Wisconsin's Reforestation Programs
2013 Annual Report

Wisconsin Department of Natural Resources
State Forest Nursery Program and
Forest Genetics Program

and

University of Wisconsin-Madison
Department of Forest and Wildlife Ecology

Forest Genetics and Tree Improvement Program

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Introduction

The Wisconsin Department of Natural Resources' (WDNR) reforestation efforts consist of three linked programs: 1) the Tree Improvement Program, a WDNR collaboration with the UW-Madison, Department of Forest and Wildlife Ecology, which works to ensure WDNR tree seedlings are well adapted to Wisconsin growing conditions and have a high potential for survival and growth; 2) the State Forest Nursery Program which produces and ships native forest tree seedlings for reforestation projects from facilities in Boscobel, Wisconsin Rapids, and Hayward to customers throughout Wisconsin; and 3) the Reforestation Monitoring Program which monitors out-planted seedlings to assess seedling survival, growth, and long-term health.

2013 Tree Improvement Program Highlights

The Wisconsin Forest Tree Improvement Program, with the long-term support of the state forest nurseries, continues to develop and manage tree seed orchards using a combination of parent tree and family selection, progeny testing, and selective breeding. First-generation seed orchards currently are established for white pine, jack pine, red pine, white spruce, red oak, and black walnut. Second and third-generation seed orchards are established for jack pine.

Priority assignments completed during 2013 included three-year height measurements and analysis for the 80-family, Black River Falls third-generation jack pine selection and breeding population; seeding and out-planting of a 184-family, second-generation red pine progeny test; design and completion of a 50% thinning at the 20-family, Ten Mile Creek III second-generation selection and breeding population; establishment of a one-acre butternut seed orchard at the Hayward State Nursery; and the design and implementation of a 60% thinning of the 240-family Black River Falls white pine progeny test. The program also continues to monitor seed orchards and progeny tests and collect data on variation in tolerance and resistance to various pathogens.

Seed orchards are the principle technology used to produce genetically-improved seed in quantities large enough to support nursery production. We continue to expand and develop our seed orchards for white pine, jack pine, red pine, white spruce, black walnut, and butternut production (Table 1). Our work also emphasizes the critical maintenance and intensive management of seed orchards to facilitate the production of greater quantities of improved seed.

Species	Acreage	Counties with Major Orchards
Jack Pine	25	Jackson, Rusk, Waushara, Wood
Red Pine	45	Iowa, Oneida, Wood
White Pine	52	Jackson, Oneida, Washburn
White Spruce	34	Marathon, Oneida, Washburn
Black Walnut	14	Crawford, Grant, Green
Butternut	2	Crawford, Sawyer

Table 1. WDNR Genetics Plantings Acreage by Species

This report highlights the 2013 program activities and accomplishments for our principal tree improvement species. Please feel free to contact program staff if you have any questions or comments.

Jack Pine

Jack pine (*Pinus banksiana*) is one of the most widely-distributed conifers in Wisconsin and is the third most popular (by nursery sales) tree species produced by the DNR State Nursery Program. The species is characterized by large amounts of genetic variation for characters such as growth rate, stem form, and wood specific gravity. Opportunities for genetic improvement in these traits are exceptional as jack pine has a precocious flowering habit, produces regular cone crops, and is adapted to a wide range of sites.

Black River Falls selection population

The three-year-old, 80-family, third-generation jack pine selection and breeding population in the Black River State Forest (Jackson County) was measured for height in October, 2013. Each family is represented by 40 individuals planted randomly in four-tree plots with 10 replicates of a Randomized Complete Block Design. The data will be analyzed during the winter to evaluate family differences. Unfortunately, the 2012 drought, coupled with a late summer drought in 2013, took a toll on the planting. A survey of mortality over the summer recorded 10.5% of the 3200 trees as dead. An additional 6.8% were recorded as weak or dying during the October tree measurements (Figure 1).

Figure 1. Black River Falls jack pine water-stressed trees, Fall 2013.
(Photo by Kristin Peterson, WDNR)

While water stress was the primary culprit for mortality, secondary stressors included redheaded pine sawfly, white grub root feeding, white pine tip weevil, and *Armillaria* root disease. Fortunately, this mortality did not remove more than 13 individuals from any family, and most families lost only five individuals. The planting will be surveyed in the spring of 2014 for any additional mortality.

Ten Mile III breeding population

This planting was established in 1999 (Wood County) and contains second-generation trees from 20 families originating from controlled crosses made in two different Wisconsin breeding populations. The planting is composed of trees drawn from Minnesota, Wisconsin, and the Upper Peninsula of Michigan. Using selection criteria such as growth rate (height), tolerance/resistance to pine-oak gall rust (*Cronartium quercuum*), and stem form, superior parent trees were selected from within each family and creation of a third generation via controlled crosses was started in 2009 and completed in 2012. During the summer of 2013, the planting was thinned to seed orchard spacing by tree improvement personnel, leaving only superior individuals from each of the 20 families. The thinning process will allow space for increased cone production, easier harvesting of cones, and minimal competition. In all, 50% of the trees were removed. During the winter of 2014, seeds from the controlled crosses will be planted in the greenhouse as the first step in creating a third-generation population.

Eastern White Pine

Black River Falls test planting

To better understand the extent and patterning of variation in Wisconsin's white pine (*Pinus strobus*) resource, a provenance/family test was planted in 2003 on a 10-acre site in the Black River State Forest (Jackson County). The planting is composed of 8,000 trees drawn from 240 families (single-tree collections of open-pollinated seed) from Wisconsin, Minnesota, and the Upper Peninsula of Michigan. Data collected from this planting show significant regional and stand differences in growth rate. Additionally, assessments of natural infection of white pine blister rust (*Cronartium ribicola*) within the planting show significant differences in susceptibility between families. Now, at 11 years of age, the planting is in need of thinning to prevent stunting of superior trees. Using 10-year height and blister rust data, 60% of the trees were selected and marked for removal during 2013. Roughly one-third of the marked trees were cut and removed from the planting by tree improvement staff during the late fall and early winter of 2013 (Figure 2). The remaining trees will be removed in early 2014. Eventually, the planting will be managed to provide a source of improved white pine seed.

Figure 2. Black River Falls white pine test planting following thinning, Fall 2013. (Photo by David Stevens, UW-Madison)

Red Pine

Figure 3. Out-planting red pine seedlings at Wilson State Nursery, Summer 2013. (Photo by Kristin Peterson, WDNR)

Three red pine (*Pinus resinosa*) 15-acre seedling seed orchards comprised of 310 families from native Wisconsin stands were established in 1970 at Avoca (Iowa County), Lake Tomahawk (Oneida County), and Ten Mile Creek (Wood County). These seed orchards were thinned in 1980 and again between 2004 and 2006 to retain the tallest families and best-formed trees for seed production.

In order to create a second-generation red pine seed orchard, the 'best' individuals from within the tallest 125 families at each orchard were identified during 2003-2004. Between 2004 and 2009, open-pollinated cones were harvested from these trees as they became available. Over 18,000 seeds from these collections, representing 185 families, were sown in the greenhouse during January and February of 2013. Trees were grown in the greenhouse through the winter and spring of 2013 and then transplanted into nursery beds at Wilson State Nursery in June (Figure 3). In all, 9159 trees were transplanted by tree improvement staff with the generous help of DNR Forest Health staff members Liz Wood, Phyllis Ziehr, and Becky Gray. These trees will remain in the nursery beds through 2014 and then planted to create a second-generation seed orchard at the DNR's Hayward State Nursery facility in 2015.

White Spruce

White spruce tree improvement efforts are currently focused on the intensive management of seed orchards and the evaluation of progeny tests in order to supply improved seed for the State Nursery Program. While the program manages four orchards located in central and northern Wisconsin, the two youngest orchards are currently the main focus. These orchards are both located on DNR wildlife area properties; one in the Mead Wildlife Area (Marathon County) and the other in the Sawyer Creek Wildlife Area (Washburn County). Planted in 1982, the six-acre Mead white spruce seed orchard consists of 175 families representing elite material selected by the Forest Service from the Ottawa Valley, Ontario and the Lake States regions. The 10-acre Sawyer Creek progeny test planted in 1989 contains an additional 168 different families selected by the Forest Service throughout the Lake States region and the Ottawa Valley of Ontario. Extensive thinning has been completed within both seed orchards during the last five years by program staff. The thinning process retains the best individuals within each family and allows for access by a lift truck for cone harvesting. In the future, grafts will be made from the 'best' individuals at each orchard to create a clonal seed orchard at Hayward State Nursery. There were no cone crops large enough to justify collections at any of the white spruce orchards in 2013.

Black Walnut

Black Walnut (*Juglans nigra*) remains a species of great importance to landowners and the forest products industry in southern Wisconsin. The black walnut resource in Wisconsin is estimated at 350 million board feet of saw timber, with an estimated value of more than $436 million (2010 dollars). To date, efforts have focused on identifying superior quality trees in natural stands and grafting scion wood from those trees into clonal seed orchards. An additional thirty-six grafts from eight selections will be added to the seven-acre Bell Center (Crawford County) clonal seed orchard in the spring of 2014.

Butternut

Butternut (*Juglans cinerea*), a close relative to black walnut and often referred to as white walnut, has been slowly declining in Wisconsin since the exotic butternut canker disease (*Ophiognomonia clavigignenti-juglandacearum)* was first reported here in 1967. Trees infected with the fungus develop branch and stem cankers that eventually girdle and kill the tree. A native Wisconsin tree, butternut is found throughout the state, with the exception of the northern-most counties, and is prized for its quality lumber as well as its nuts for both wildlife and human consumption.

Beginning in the 1980's, an increasing number of canker-free trees have been identified (mostly by the USDA-Forest Service) growing alongside infected trees throughout butternut's native range, including here in Wisconsin. While tolerance or genetic resistance to the disease has yet to be confirmed, putatively disease-free trees from infected areas have been screened by the USDA-Forest Service and demonstrate a wide phenotypic variation in susceptibility to the disease. Recent studies have shown a high level of genetic diversity present within the species across its range. An additional obstacle compounding the selection and re-introduction of disease-resistant butternut is its ability to hybridize with Japanese walnut (Juglans ailantifolia).

Figure 4. Hayward State Nursery butternut seed orchard, Summer 2013. (Photo by David Stevens, UW-Madison*)*

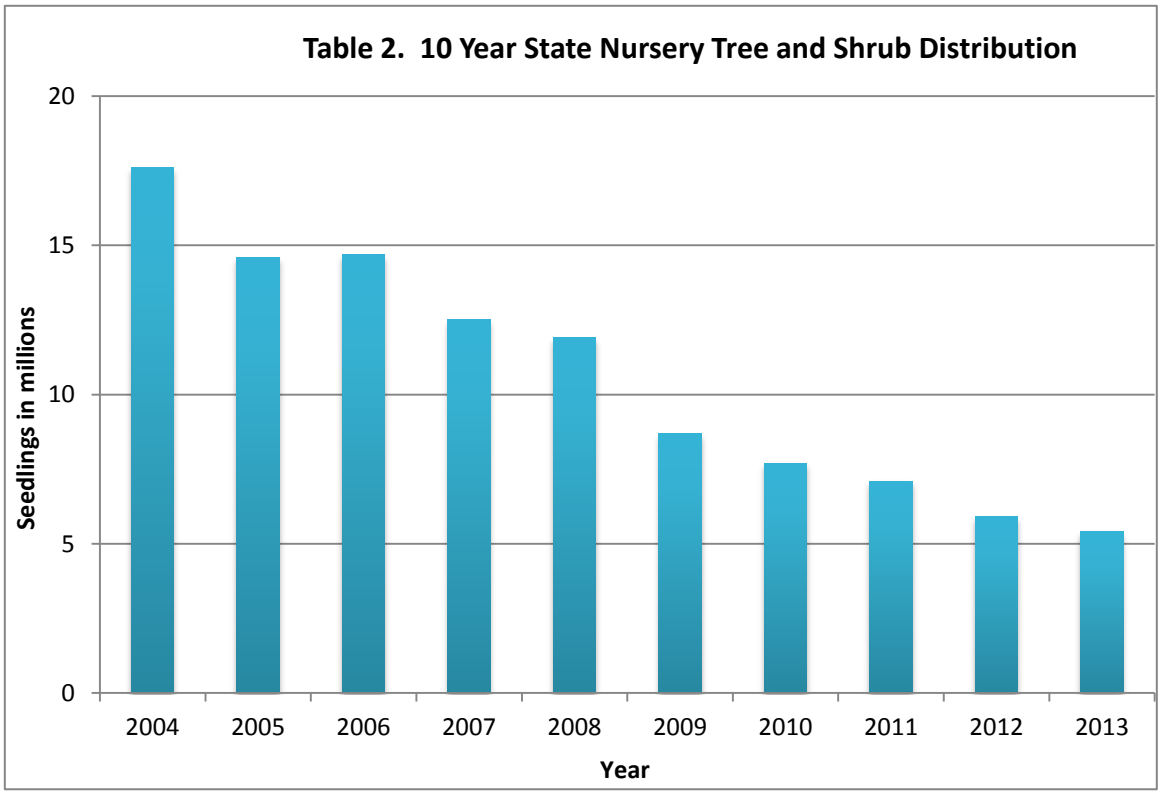
Since Japanese walnut's first introduction into the United States in the 1860's, naturally-occurring interspecific hybrids and backcrosses between the two species have been found across much of butternut's native range. Designated as *Juglans X cinerea*, these complex hybrids are more productive, vigorous, and disease-resistant than butternut while maintaining the appearance of butternut.

Due to their near identical appearance, using morphological traits to distinguish between pure butternut and the hybrid is difficult and has greatly complicated the selection of disease-resistant butternut. Fortunately, the identification of DNA-based markers has made it possible to positively distinguish between the hybrid and the species. Once a putatively disease-free tree is identified, scions from the tree are grafted into a clone bank. Black walnut, a close relative of butternut, is used as rootstock given its resistant to the disease, thus eliminating possible infection of the graft from the rootstock.

The Tree Improvement Program has partnered with the USDA-Forest Service to establish a butternut genetic conservation project. In the spring of 2013, seventy-nine putatively disease-resistant, grafted 'pure butternut' clones were planted at Hayward State Nursery (Figure 4). These clones represent 14 selections made in five different Wisconsin counties together with two selections from two bordering Minnesota counties. The selections and clones were made by staff from the USDA-Forest Service's Oconto River Seed Orchard and the USDA-Forest Service's Hardwood Tree Improvement and Regeneration Center (HTIRC) in West Lafayette, Indiana. More selections will be added to the planting over the next few years as they become available. Additionally, HTIRC provided 74 grafts drawn from 20 selections originating in Wisconsin. These grafts were out-planted at the Kickapoo River Wildlife Area, Bell Center Unit (Crawford County) in 2010. Research is currently underway by Forest Service scientists to measure variation in resistance to butternut canker as well as define the heritability of any resistance traits in offspring.

2013 Nursery Program Highlights

The State Nursery Program is proud to consistently produce high quality, well-adapted tree and shrub seedlings for the entire state. In 2013, the program distributed a total of 5,416,542 bare-root seedlings and shrubs to 2271 customers. Since the program's inception in 1911, a total of more than 1,605,753,000 seedlings have been distributed. Approximately 80% of the 2013 distribution total consisted of conifers with the balance made up of hardwoods and shrubs. Of the paid orders, 84% were distributed to private landowners followed by 10% to county forests.[1]



The 10-year trend (Table 2) for nursery distribution shows a continuing decline in trees and shrubs sent to customers.

[1] Data source: State Nursery Tree Distribution & Tree Planting Report 2013, DNR

Factors affecting this decline include a general downturn in the economy, agricultural commodity price increases leading to land remaining in (or re-entering) agricultural production, taxes on recreational land, changes in large (industrial) land ownerships across the state, county forest partners shifting to containerized stock from other sources, and declines in federal cost-sharing programs that reduce incentives to plant trees.

Overall stock quality remains high. Since 2006, the nurseries, in cooperation with DNR forest health staff, have monitored red pine nursery stock for the fungus, *Diplodia pinea,* the pathogen responsible for Diplodia shoot blight/collar rot. In 2013, 315 asymptomatic 1-0, 2-0, and 3-0 red pine seedlings from Griffith State Nursery were tested for the presence of the disease. This was the first year that 1-0 seedlings were tested and no asymptomatic infections were detected. The asymptomatic infection rates in 2-0 and 3-0 seedlings were 2.4% and 6.7% respectively, well below the 10% threshold tolerance level used for management purposes. Infection rates appear to be related to local weather conditions, specifically humidity, temperature, and wind, during aeciospore dissemination. As such, weather conditions are monitored closely during this time period and preventive actions are adjusted accordingly. Given a consistently low infection rate of less than 3% since 2006, Wilson State Nursery was not tested this year. Seedlings will be tested again in subsequent years, however, to insure that the infection rate remains low.

Overall seed purchase and collection efforts for 2013 were successful. Procurement goals were met or exceeded for basswood, black cherry, shagbark hickory, sugar maple, bur oak, swamp white oak, white oak, black walnut, hazelnut, and wild plum. The red oak acorn crop was poor this past fall and resulted in collection quantities falling short of the established goal. Jack pine cone purchases reached 970 bushels, yielding approximately 400 pounds of cleaned seed.

Griffith State Nursery

The winter of 2012-2013 brought deep snow and very cold temperatures to the nursery from December until late March. As a result, lifting began slowly on April 16th, with most of the stock remaining frozen in the ground until April 29th. Stock distribution by county trucks was pushed back a week. While a grading crew started on April 17th, it was hit-and-miss as to what and how much could be lifted prior to the frost leaving the ground. Once the ground was frost-free, stock lifting and shipping proceeded on schedule until lifting was completed at the end of May. In nursery manager Jim Storandt's 28 years with the nursery, this was the latest spring lifting season he has witnessed and quite different from the record-breaking early lifting season seen in 2012.

Winter snow and cold were followed by a cool, wet spring from May until June. As a result, spring seedling germination was delayed by 2-3 weeks. Conifer germination was satisfactory overall with most species meeting goals with the exception of white spruce and tamarack. Hardwood germination, on the other hand, was below goal for many species, especially for white, bur, and swamp white oaks. The wet, cold spring caused a large portion of the seed to rot prior to germination. Meanwhile, both red oak and black cherry had good germination percentages. During July and August, the weather changed considerably, becoming hot and dry, requiring frequent irrigation to maintain stock health.

Fall seeding goals were met for most species with the exception of red oak due to a statewide seed shortage. To compensate for this shortage, additional hardwood species were seeded. Seedbeds were fumigated with metam sodium in the fall; previously, methyl bromide was used to fumigate beds. The switch to metam sodium has resulted in a

significant cost savings for the State Nursery Program; however, the overall effectiveness of metam sodium compared to methyl bromide still needs to be evaluated in future years to ensure its cost effectiveness.

Several of the nursery's historic buildings were maintained during the summer and received a new coat of paint as well as repairs to windows and doors. In an ongoing effort to assist county forestry programs, five tree planting machines were brought to the nursery for repairs and preventative maintenance. Work performed included sand blasting, painting, repair, and the replacement of worn parts. This work helps defer nursery staff time from stock production time codes, accomplishes needed work for the Division of Forestry, and extends the function of machines for years to come.

Wilson State Nursery

Spring 2013 came with many challenges. Stock distribution started out to be one of the latest on record due to persistent ground frost, with some conifer beds remaining frozen into mid-April. Following the thaw, rainfall added to the challenge of getting seedlings lifted and ready for shipment. In the end, all ordered stock was able to be lifted and shipped while still dormant due to the concerted effort of nursery staff, supplemented by two days help from a private contract lifting crew and a grading crew at the nearby Wisconsin Department of Corrections Boscobel Secure Program Facility. The cool, moist conditions, while a hindrance to nursery crews, led to a good planting season for seedlings once in customer's hands.

As part of the spring seedling distribution, roughly 5,000 one-year-old American elm seedlings were lifted and distributed by the nursery to partners with the USDA-Forest Service (USFS), Wisconsin DNR, Army Corps of Engineers, Iowa DNR, Minnesota DNR, and the Southwest Badger Resource Conservation & Development Council. This program partnership uses seed from USFS-selected American elm cultivars confirmed to have varying levels of Dutch Elm Disease (DED) tolerance. While work continues on testing the actual tolerance levels in these selections, research has shown that some DED tolerance is heritable. Given that, this seed is considered "enriched", as it has a high probability of having some DED tolerance. While the long-term goal of the project is to introduce tolerance/resistance genes into native American elm populations, the immediate purpose of the program is to learn how to successfully grow and establish elm in a forest setting. This knowledge will be important as more suitable DED tolerant growing stock is developed and as restoration of bottomland forests becomes more critical due to impacts from Emerald Ash Borer and other invasive species. The plantings will be maintained and monitored for survival, height growth, and DED incidence in future years by the partners. Additionally, another 2,500 seedlings were carried a second year and will be distributed as part of the same program in the spring of 2014.

The growing season started out with very late seed germination. Due to cool, wet conditions, most species germinated a full two weeks later than normal, with species such as walnut and hickory not germinating until mid- to late May. While temperatures warmed some in June, there was no shortage of moisture. One rain event in late June brought approximately 17 inches of rainfall to nursery beds in a 30-hour period. As a result, there was significant nutrient leaching from the seedling root zones. This leaching, coupled with the late seed germination, presented a significant challenge in growing several species to quality size. Fortunately, August brought warmer temperatures and reduced rainfall which allowed most species to meet quality seedling specifications.

The nursery continues to improve on its Integrated Pest Management (IPM) program by using carefully-timed fumigation, a variety of herbicide regimes, proper plant nutrition, and hand-weeding when needed. As a result, hand-weeding was eliminated in walnut beds and drastically reduced in much of the 1-0 seedling crop. Seedbeds that were fumigated last fall using Chloropicrin in place of methyl bromide, however, developed new weed issues. In particular, lambsquarter became abundant and required hand-weeding to control. On the whole, weed pressure was manageable using the IPM program together with winter wheat cover crops and a small hand-weeding crew.

Nursery staff trial-planted aspen root and stem cuttings. For years, demand for aspen seedlings has outpaced the nursery industry's ability to reliably produce them. Wisconsin's State Nursery Program has had occasional successful plantings of aspen seed, but more often than not, the crop failed to germinate or the tiny seedlings were lost to harsh sun immediately after germination. The need for a more reliable production method has led to numerous experiments over the years. Finally, one experiment may have potential.

In the spring of 2013, approximately 100-200 large aspen "weeds" were culled from red and white oak seedlings as the stock crossed the grading belt. These seedlings were stored in the cooler until the end of the shipping season. Following this, the roots were methodically run through a paper cutter until all roots were reduced to 4-inch pieces. Tops were also cut into 4-inch lengths and kept separate from the roots. A nursery bed was rototilled and prepped for planting just as if it were to be seeded.

Figure 5. One-year aspen grown from root cuttings. (Photo by Ron Overton, USFS)

Trenches 1.5-2.0 inches deep were made with a hardwood planter with its packing roller removed. The root cuttings were then hand sown into the open trenches and covered with soil. Everything from hair-thin roots to pencil size and greater was sown. The tops were then planted separately from the root cuttings.

Following sowing, frequent irrigation was used to maintain a consistently moist seedbed and the first new shoots appeared in the root cutting beds approximately three weeks later. These shoots grew rapidly, and by late summer, were waist high with several cuttings producing multiple stems (Figure 5). Limited numbers were dug, and it appears that most of the trees were produced on approximately one-eighth-inch diameter root cuttings. For future plantings, root size will be used as a variable to determine the optimum diameter root. Stem cuttings, on the other hand, did not fare as well. While most broke bud and produced leaves, nearly all failed to produce roots and died. The stem cuttings that did survive came from the lowest cutting from each stem with a root collar. These cuttings produced new roots and developed into vigorous seedlings even though the roots had been completely removed. In all, around 5,000

aspen seedlings were produced and will be made available for distribution in the spring of 2014.

As with everything else, seed collection was late in 2013. While there was a mediocre crop of white oak in the southern part of the state, the crop from northern locations was better. In contrast, red oak seed crops were rare across the entire state with a few good pockets in the far southwestern part of the state. Swamp white oak, walnut, sugar maple, and basswood all had great seed crops. Wilson State Nursery staff was involved in seed collection and replenished inventories of several shrub species, including high bush cranberry, hawthorn, prairie crab, and dogwoods.

The nursery prepped about seven acres of nursery beds for fall seeding. This included peat amendments to adjust soil organic matter levels, and fertilizer amendments to adjust soil nutrient levels. These beds were then fumigated with metam sodium for both weed and soil disease management. Fall seeding was completed by mid-October with a remaining quarter acre to be completed in the spring of 2014. Winter wheat was sown as 'living mulch' in all hardwood and shrub seedbeds. Winter wheat has replaced hydro mulch applications on these beds, providing a considerable cost savings while still protecting seed. Trials with winter wheat continue on conifer beds, especially white spruce, with the goal of replacing the shade cloth now being used over young seedlings. Trials have been conducted for the last three years with some success, but fine tuning the process will continue to gain greater consistency.

Hayward State Nursery

Lifting season was delayed as beds were unexpectedly blanketed under a six-inch deep layer of heavy spring snow on April 18th. Cold temperatures also lingered longer than desired and frost persisted in the ground. In time, however, nearly 300,000 trees and shrubs were distributed by the nursery to customers. The spring marked the historic end to seedling production at the facility with the last of its stock lifted and distributed.

With the end of stock production, a new era is underway at Hayward as nursery beds began their conversion to other uses. Two acres of shrub production area were established, focusing on hazelnut, red osier dogwood, silky dogwood, plum, and juneberry. In partnership with UW-Madison, the first seed orchard was established on site with approximately one acre of improved butternut stock planted. Future seed orchards for jack pine, red pine, white pine, and white spruce are planned in the coming years to utilize 29 acres of nursery beds. Other new plantings on the property include an American hazelnut cooperative research project with UW-Extension, Bayfield County. This planting will be used to evaluate future commercial production options for the species. Discussions are also underway with UW-Superior to pursue a highbush cranberry project in 2014. The property also became a temporary home to 39 endangered dotted blazing star (*Liatris punctata*) plants in late 2012 as part of the Stillwater,

Minnesota lift bridge rehabilitation project across the St. Croix River. Many of these plants blossomed this year and seed was collected and sown to further expand the project. Additionally, with help from the DNR Wildlife Program, about 24 acres of open nursery beds were seeded with various prairie grasses as cover crops in the fall.

Statewide reforestation monitoring surveys conducted over the last seven years have generated many questions about herbicide application rates and impacts on seedling survival. As a result, a three-year Oust herbicide trial was put in place at Hayward. Thirty-two nursery bed rows containing a winter wheat cover crop were planted with 15

plants each of 25 various conifer, hardwood, and shrub species. Oust XP was then applied at 0.5, 1, 2, 3, and 5 ounces/acre. Plant impacts will be monitored over the next several years. For more information on the trial, check out the July 2013 Nursery News. http://dnr.wi.gov/topic/treeplanting/documents/newsletters/nurserynews-july2013.pdf

Seed collection remains a viable task at Hayward, focusing primarily on jack pine. To stimulate interest and make cone collection more convenient for sellers, two new jack pine buying stations were established, one at Barnes and one at Washburn, in partnership with the State Nursery Program.

Hayward continues to be the primary seed processing and storage facility for the State Nursery Program. Several meetings were held with USFS staff during the year to help evaluate ways to update Hayward's current equipment and streamline processing. Final plans should be determined in 2014. Meanwhile, based on these recommendations, staff began briefly dipping conifer cones in a hot water bath to help stimulate the opening process before placing them in a drying kiln. This method will result in reduced overall processing costs by extracting more seed from each cone while also reducing the time cones are left in the drying kiln. All seed generated from processed conifer cones not used by the nursery system is sold on the open market, producing additional revenues for the program. In another effort to streamline the process, nursery staff attended a USFS-sponsored seed cleaning and processing workshop in Illinois to further their knowledge and remain up-to-date on new technologies.

House cleaning took on a new meaning at Hayward as most of the nursery's equipment was transferred to the other two operational nurseries. A number of remaining items were sold as surplus through an on-line auction system.

Reforestation Monitoring

Introduction

In the summer and fall of 2013, the nursery assistant managers visited 183 first-year reforestation monitoring sites (Wilson-65 and Griffith-118), 35 third-year monitoring sites (Wilson-16 and Griffith-19), and 6 seventh-year monitoring sites (Wilson-3 and Griffith-3) to determine the status of new tree and shrub plantings with DNR nursery stock. These sites were scattered around all regions of the state on public and private properties. To increase landowner contacts over a larger geographic area, the nursery system hired two limited-term employees (LTE).

Weather Conditions

Planting and growing conditions varied statewide. The season started extremely late as very cold and snowy conditions in March and April delayed nursery stock lifting and delivery until late April through mid-May. The weather stayed cool and wet, providing ideal conditions for planting and early season tree health. Then, in mid-July, a large swath of the southwestern two-thirds of the state entered a dry spell. This below normal

precipitation pattern remained in place until early September. By the time sufficient rains fell widely over the region, many plantations, especially in the central sands and southeastern forests, were stressed. Timely late summer and early autumn rains helped replenish soil moisture and bolstered hope for a reasonable start to 2014.

Landowners

As in years past, the majority of seedlings ordered are planted on public property including state forests and lands, and county forests. However, the majority of sites

visited are owned by private landowners. These folks are very open to discussing and exhibiting their plantations, and many asked to be included in the site visit. These requests are accommodated whenever possible, regardless of the challenges associated with coordinating schedules. Nevertheless, what is lost in efficiency is made up for in positive public relations.

Plot Data

Wilson State Nursery – 2013 Planting Surveys – Roger Bohringer

Wilson State Nursery assistant manager and nursery LTE, Laura Lorenz, visited 65 first-year sites during the 2013 field season (Barron-5, Buffalo-3, Burnett-4, Chippewa-1, Colombia-5, Crawford-1, Dane-2, Dodge-1, Douglas-2, Eau Claire-3, Grant-3, Green-1, Jackson-2, Kenosha-1, LaCrosse-1, Lafayette-4, Monroe-3, Pepin-1, Pierce-4, Polk-1, Richland-3, Rusk- 2, St. Croix-4, Trempealeau-5, and Vernon-3). Counties visited ranged from Kenosha in the far southeast, all the way to Douglas in the far northwest. Sites were selected for a visit based on an order of 3000 or more seedlings. Surveyed plantings ranged from do-it-yourself habitat projects to reforestation of large pine clear cuts. Thanks go to DNR and County Forest foresters for their assistance in locating some of the hard-to-find properties and for providing maps.

Figure 6. Flood debris on white oak seedling, Crawford County. (Photo by Roger Bohringer, WDNR)

Overall, 2013 was a pretty good year for tree planting. However, because of the late, wet spring, many plantings weren't completed until the end of May with some going into June. While holding stock for that long, even with excellent cold storage, is far from ideal, sometimes the cards need to be played as they are dealt. Red pine mortality rates were skewed high due to relatively high mortality on two late plantings. This mortality was due largely to the fact that red pine is the first to show stress from prolonged storage, and is generally planted into low fertility, sandy sites. Most other species surveyed in the late plantings looked surprisingly well. There were several local weather events that affected 2013 plantings in the surveys. Grant, Crawford, Richland, and Vernon Counties all had sites where trees were lost due to flash flooding in June. Though planters did everything right, six feet of fast moving water does not show much respect for seedlings (Figure 6). Sites in Buffalo, Trempealeau, and Eau Claire Counties all showed varying degrees of hail damage, with some quite severe (Figure 7). A few seedlings were bruised bad enough to cause top dieback, but most formed callus around the damaged area and recovered nicely. The majority of seedlings will recover completely by the end of their second growing season.

Figure 7. Hail damaged stem, Trempealeau County. (Photo by Roger Bohringer, WDNR)

Sixteen third -year sites were surveyed in 2013 (Buffalo-2, Crawford-3, Eau Claire-1, Grant-1, Jefferson-1, Pepin-1, Pierce-2, Polk-1, Sauk-2, St. Croix-2) and three seventh -year sites (Grant-1, Sauk-2). Nearly all of these sites were in survival mode with many plantings losing an entire season of growth due to the severe drought in 2012. This loss of growth is reflected in their average height data (Figure 8). Most seedlings were still struggling to get above the competition. Deer and rodent damage also held many trees back. One notable exception was a hardwood planting on an agricultural field conversion in Devil's Lake State Park. Red oak, white oak, walnut, and cherry were planted at high densities into soybean stubble in 2011. At year three, most of the field was covered with 6-8 feet tall giant ragweed, with very little else for competition. The ragweed acted as 'trainers', forcing vigorous growth from the hardwoods. Several red and white oaks were 4-5 feet tall after just three growing seasons, with some surpassing six feet. The majority of that growth was produced during the summer of 2013. This is a good illustration of what is possible with good control of grassy competition, fertile soil, and a very low deer population.Overall survival for all species combined in plantings surveyed was 93.6%. Survival of combined hardwoods was 96.1% and combined conifers survived at a rate of 92.0%. One hundred four wildlife shrubs were encountered within the plots. All shrubs were alive, although about 9% did show damage, primarily from deer browse.

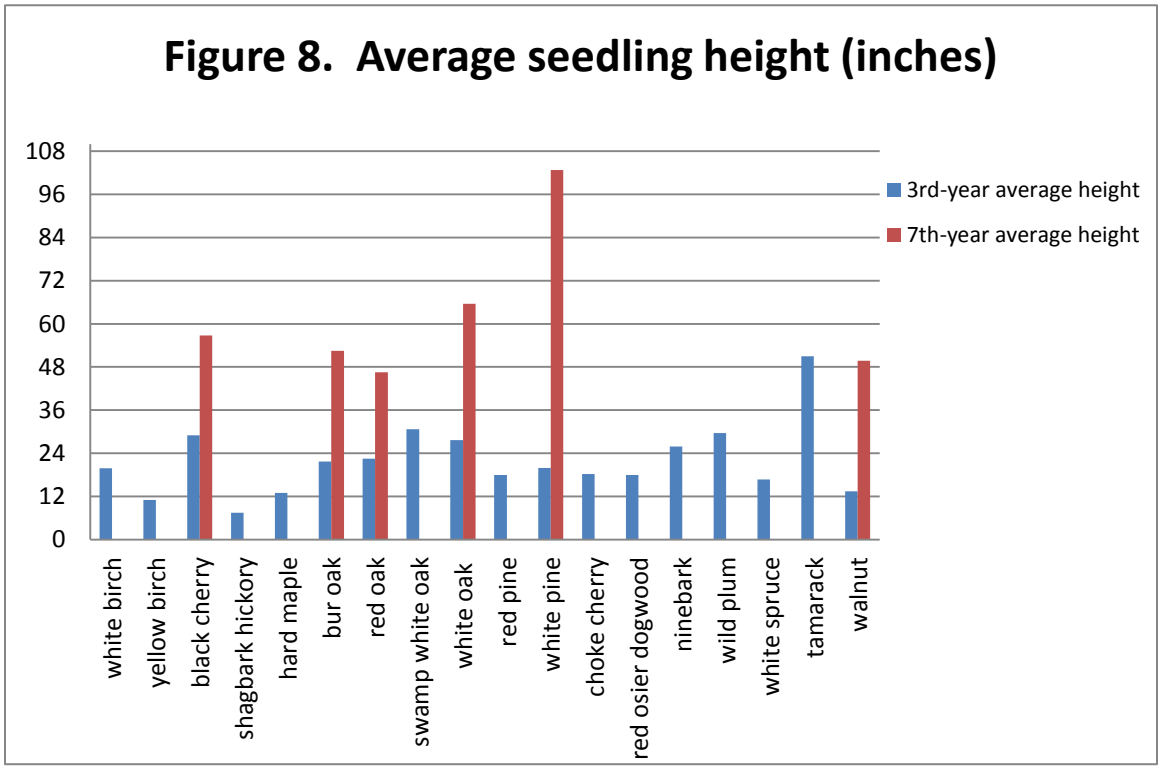


Figure 9. Marinette County Forest, 2011 planting. (Photo by Jeremiah Auer, WDNR)

Griffith State Nursery – 2013 Planting Surveys – Jeremiah Auer Griffith State Nursery assistant manager and nursery LTE, Roger Jaworski, visited 118 first-year sites during the 2013 field season (Adams-7, Bayfield-1, Brown-2, Clark-4, Door-2,

Douglas-2, Fond du Lac-9, Green Lake-6, Juneau-4, Kewaunee-5, Lincoln-5, Manitowoc-3, Marathon-4, Marinette-6, Marquette-5, Oneida-6, Outagamie-9, Portage-6, Sawyer-1, Shawano-8, Vilas-5, Waupaca-6, Waushara-4, Winnebago-3, and Wood-5). A few counties with historically low tree planting numbers had an unexpected increase. This enabled nursery staff to travel to corners of the state not commonly visited. The plantations established in central Wisconsin were planted late due to the cold spring. The soils were cool and moist and provided an ideal environment for seedling establishment. Unfortunately, as mid-summer approached, the weather changed to much drier and warmer. The seedlings on the sandier soils in the southern two-thirds of the state suffered and in some cases, were not able to survive. The heavy soils of the east provided some refuge to the new roots. The plantations farther north, specifically north of State Highway 29, fared much better. Scattered rains fell throughout the summer, and the warm conditions provided a great environment for growth and development. Overall, the seedling survival rate was 85%. However, this number is slightly skewed as plantations in the south were doing well early in the season during monitoring, but likely experienced significant loss later. Competition was relatively well-controlled area wide; most seedlings experienced only minor grass and forb competition. However, more than a few plantations did struggle with heavy grass competition. Planting depth seemed to be a problem, especially with large plantings on county and state forest lands.

Nineteen third-year sites were surveyed in 2013. The 2011 planting year was a terrific time to establish a tree plantation; abundant precipitation and very warm weather combined to provide seedlings with ideal growing conditions. The following year, 2012, was much different. A very early spring gave way to an extremely dry summer that only relented in the early autumn. The cold, wet winter and spring of 2013 seemingly offered a reprieve, but for many seedlings, it was too late. Of the 19 sites visited (Adams-1, Door-2, Fond du Lac-1, Kewaunee-2, Manitowoc-3, Marinette-3, Marquette-1, Portage-1, Shawano-2, Waupaca-1, and Waushara-2) in their third growing season, three were complete losses.

Figure 8. Private landowner property, 2013 planting. (Photo by Jeremiah Auer, WDNR)

Two of these landowners were interested in complete replacement and are currently seeking financial assistance opportunities. Eight other sites sustained 30-65% mortality. Originally, four of these sites had relatively low seedling densities, so the ability of the seedlings to capture the site is questionable. The other four sites began with above average tree densities. Many of these sites also had issues with high deer browse pressure. Depending on reforestation goals, interplanting and seedling protection may be necessary. The last eight sites performed well. Seven of the sites had very good site preparation and four are currently well maintained with consistent mowing, herbicide treatments and some herbivore controls. One site is dealing with heavy deer browse, but the seedlings, once beyond the herbivory pressure, are growing well.

This was the first year that the nursery staff has been able to visit plantations after the seventh year of growth. These stands were visited after their third season of growth in 2009 as well. Of the original eight sites visited in 2009, three landowners responded to a request for a final visit. The sites had many commonalities: all were planted in nutrient-laden, silt loam soils on the eastern edge of Wisconsin (Door-1, Kewaunee-1, and Manitowoc-1), involved some chemical site preparation and maintenance for a minimum of two years, had professional forester advice, and utilized a variety of site appropriate hardwood and conifer seedlings.

Figure 10. Private landowner, 2007 planting. (Photo by Jeremiah Auer, WDNR)

Conclusions

The long, cold, and snowy spring provided ideal conditions to plant seedlings, albeit much later in the spring than usual. The dry weather that followed in mid-summer disrupted these conditions and many plantations in the southern portion of the state suffered. However, most plantations entered the fall with reasonable success and should be able to survive the winter of 2013-2014 and prosper this coming spring. These negative climactic impacts were lessened, as in past years, by those landowners that prepared the planting site well; took care of the seedlings before and during planting and followed up with an effective maintenance regime. Hopefully, the increased interaction nursery staff has with landowners through the reforestation monitoring efforts will produce more successful plantings and more satisfied customers.